Design and FPGA implementation of Addressable Chip for Multiple Sensor Applications

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Abstract—**This electronic document is a "live" template. The various components of your paper [title, text, heads, etc.] are already defined on the style sheet, as illustrated by the portions given in this document In recent years, automation of industries became necessary to monitor and control the various units in industries. Automation reduces manpower and helps efficient operation, which leads to reduction in cost and enhance profits. In the process of automation, a huge number of sensors are used to sense the various physical quantities such as temperature, pressure etc. Whenever a physical quantity exceeds the predefined threshold value then the micro controller or microprocessor will control the parameter by activating proper circuit [1]. A micro controller has only one or two parallel ports, which are not sufficient to connect huge number of sensors. Hence, a chip (AC16) is proposed.**

This AC16 chip facilitates 16 sensors connected to six micro controller pins thus allowing it to control more number of sensors. The chip (AC16) is addressed by four address pins. Each addressable chip is connected to sensor through ADC. Every chip receives address from micro controller and appropriate chip responds with data from sensor connected to that chip.

Keywords- Automation; Sensor; Chip; ADC; ISE Simulator; Xilinx.

I. INTRODUCTION

Automation is the process of controlling the machines automatically. This helps to a greater extent in reduction of manpower and produces effective results. A large number of sensors are used in this process. Automation involves sensing the physical quantities such as temperature, pressure, humidity etc., by using various sensors. The sensor output should be amplified to drive the rest of the circuit. This process is controlled by micro controller/ microprocessor, which processes the digital data. Hence the analog data at the output of the amplifier is converted into digital format using Analog –to-Digital Converter (ADC). The micro controller reads this digital data and monitors the physical quantity. Whenever a physical quantity exceeds a pre defined threshold the micro controller controls the quantity by employing proper circuitry. The micro controller has only one or two ports, which are not sufficient to connect huge number of sensors. Hence a chip AC16 is proposed. The typical version of chip AC16 is shown in the Fig. 1.
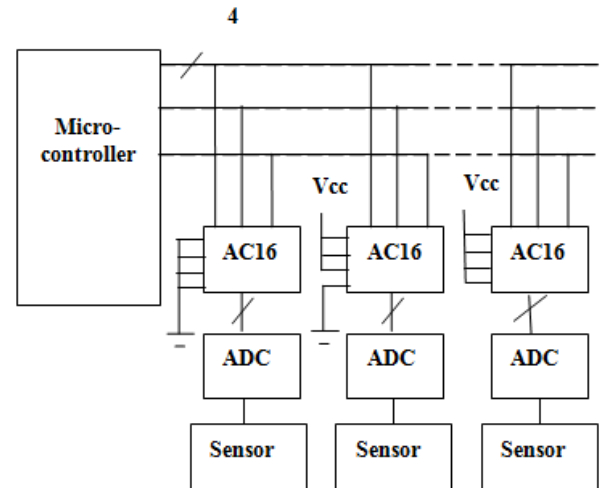

Figure 1. Typical AC16 connections

The micro controller has 3 ports. One is 4-bit address line. The other is the 8-bit data and the final port carries the Device Valid Address (DVA). Sensor is a device, which converts one form of energy into another. In the proposed chip model the sensor converts a varying physical quantity into an electrical signal. This signal, which is analog in nature, is converted into digital format when passed through Analog to Digital Converter (ADC). The parallel data thus obtained is transformed to serial data upon application to the proposed chip AC 16 and finally serial data is sent to micro controller when requested. The chip has four address pins, which are assigned an address using Vcc and ground. For instance, if the micro controller wants to read the device with address 0001, then it sends the address through 4-bit address line along with DVA. If the device address matches with the given address then that particular device will be activated with all the rest being in disabled state.

II. PROPOSED CHIP

The chip along with its inputs and output pins is shown in the following Fig. 2.The DVA signal is used to know the validity of device address requested by the micro controller. The address pins are used to assign a particular address to each chip. The signal EOC is the input signal, which indicates that data is sent to PISO. The data line indicates the 8-bit parallel data. The output pins are SOC and serial data.

The signal SOC is sent as an input to ADC requesting it to initiate the analog to digital conversion [2].
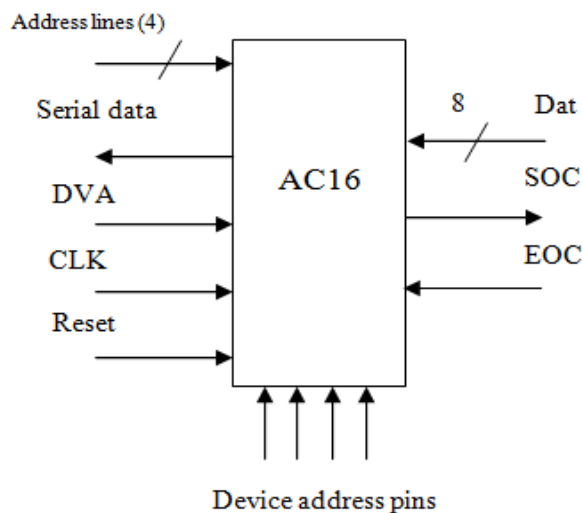

Figure 2.   Proposed Chip

A.   Operation of Proposed Chip

The controller begins to operate when it receives the DVA (Device Valid Address). It sends a signal COMP to comparator which on receiving the signal compares both the address lines and address pins. If both the inputs are equal It generate CR_OUT = '1'. Then the controller sends and start of conversion (SOC) to ADC and after an end of conversion signal is received by it the parallel data gets transferred into parallel in serial out shift register (PISO) after the LOAD signal is sent to PISO. A counter is also employed. The counter and PISO receive the commands START and SHIFT from controller. While the data is being transferred the counter gets incremented until the 8-bit data is completely sent out in a serial fashion from PISO. The PISO shift register operation is to convert parallel data into serial data. Finally the micro controller obtains the serial data. Fig. 3 shows the Internal Block Diagram of AC16.Figure 4 shows State diagram of controller.
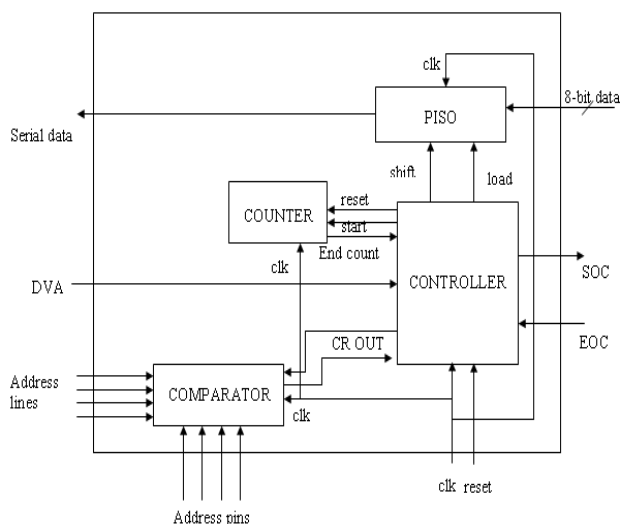

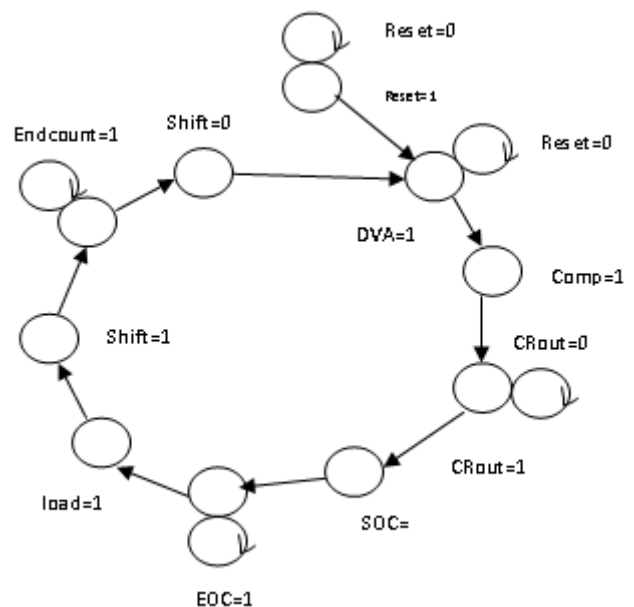Figure 3.   Internal Block Diagram of AC16

Figure 4.   State diagram of controller

III.   IMPLEMENTATION

The whole design is captured using VHDL language. Creating full custom VLSI chip includes high time and cost constrain associated with fabrication of VLSI chip. So, proposed chip will be implemented on FPGA Chip using Xilinx tools.

A.   Schematic entry:

The design is entered into a synthesis design system using a Hardware description language, the language used is VHDL.

B.   Synthesis:

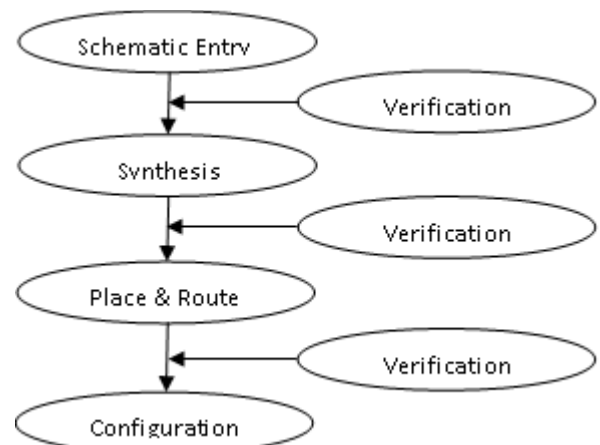A net list is generated using VHDL code and logic synthesis tool.

Figure 5.   FPGA Design Flow

C.   Place and Route:

The placement process decides the best location of the cell in a block based on the logic and desired performance. Routing process makes the connection between cells and blocks.

D. Configuration:

This is done by loading configuration data into internal memory.

E. Encoding:

This is the final step in which the FPGA is programmed with desired functionality.

IV.   RESULTS

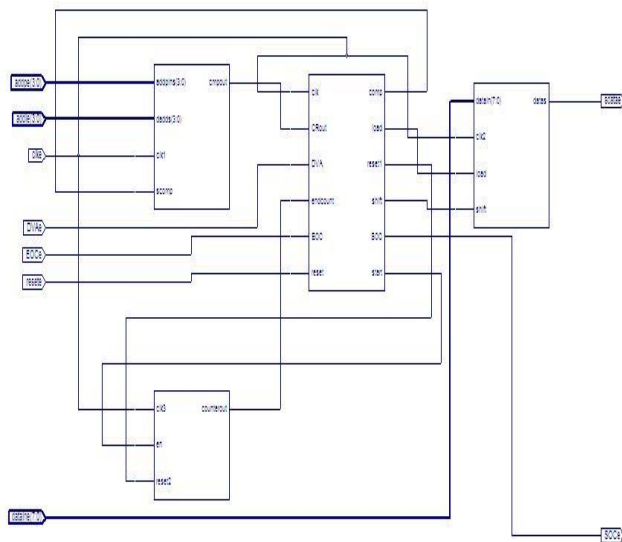The RTL schematic and simulation result of AC16 are shown in the Fig. 6 and Fig. 7 respectively.

Figure 6.   RTL schematic of AC16

Figure 7.   Simulation results of AC16

Power Analysis: Power Analysis of AC16 done using Xilinx Xpower Analysis [3] [4] is shown in the Fig 8.
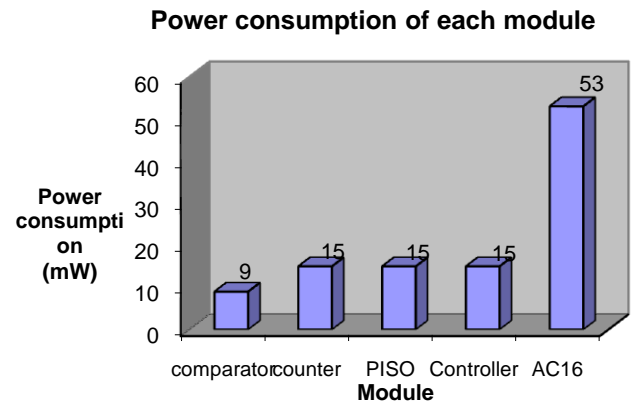

Figure 8.   Power analysis of AC16

V.   CONCLUSIONS

The AC16 is sucessfully implemented, by using this we can connect 16 sensors to Microcontroller using 6 port pins.this chip supports ADC 8080 Hand shaking protocol. By establishing serial communication between address lines of AC16 and port pins we can reduce 3 port pins, hence we can connect 16 sensors to Microcontroller using 3 microcontroller port pins. If we are able to integrate AC16 ,ADC and Sensors in single chip, then we can produce more compact sensor module.

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